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EVALUATION OF HERBICIDES FOR SOYBEANS

On Central Florida Organic Soils

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Fig. 1. (cover photo).—Soybeans on left were chemically treated with a pre-emergence CDEC spray; those on right received no treatment.

EVALUATION OF HERBICIDES FOR SOYBEANS ON CENTRAL FLORIDA ORGANIC SOILS

W. T. SCUDDER¹

INTRODUCTION

The problem of controlling weeds has been a major factor prohibiting large-scale production of soybeans on the sawgrass peat soils of Central Florida. With adequate weed control, good yields can be produced on these soils when planted after early sweet corn or other spring vegetable crops. Soybeans are grown during the summer, at a time when the land is normally fallowed or left to weeds. They show promise of becoming an important self-paying summer cover crop when used as part of the vegetable rotation.

A weed-free crop of soybeans offers many advantages as a summer cover. Fallowing, by plowing and harrowing repeatedly throughout this off-season, controls the weeds, but is expensive and tends to increase subsidence—a serious problem on peat soils. Although a cover crop of weeds lessens subsidence and conserves soil nutrients remaining from the fertilized truck crops, millions of weed seed are borne to hamper production for years to come. A well-cared-for crop of soybeans, on the other hand, not only conserves residual fertility but also adds nitrogen to the soil. In addition, a good bean yield will give a cash return much above the cost of production.

Production of soybeans in Florida has increased considerably during recent years. In 1958, 46,000 acres were harvested, producing 1,150,000 bushels of beans at an average yield of 25 bushels per acre (8).² Using the average government support price of \$2 per bushel, this crop was valued at approximately \$2,300,000. In spite of their higher productivity, Florida's organic soils were responsible for only a small percentage of this total soybean production. Potential production on these soils is considerable. Over 100,000 acres of "muckland" are devoted to vegetables in Florida, much of which remains idle from June until October.

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² Numbers in parentheses refer to Literature Cited.

Staniforth and Weber (10) evaluated several herbicides used as pre-emergence treatments in row-planted soybeans over a seven-year period in Iowa. Although they obtained good responses with their treatments, yield comparisons from the majority of their tests showed that the herbicides did not greatly enhance the effectiveness of cultivation, particularly when early cultivations were done at shallow depths. They point out that under different weather conditions, with more serious weed infestations, or with poorer cultivation procedures, benefits from the use of herbicides are greater.

In Florida, during July and early August, while the soybean plants are small, conditions are favorable for extremely rapid weed growth. Many of the common weed species on these organic soils respond to high temperatures and rainfall with growth in height in excess of 1 inch per day. Under these conditions, row planting followed by the best mechanical means of cultivation available has failed to give practical weed control. For example, a planting of nearly 1,100 acres of soybeans in the Zellwood area in 1955 was weeded repeatedly, using modern row-crop cultivators. A good yield of beans was produced in the field, but due to the high weed population in the rows, it was impossible to recover more than a small proportion of the beans at harvest time.

A review of the available literature has failed to reveal any information on the control of weeds in soybean specifically in relation to organic soils. Work has been done, however, with soybeans grown on several mineral soil types, using nearly all the presently available chemical herbicides. Working on light sandy soils in Virginia during 1955, Chappell (5) screened 17 different chemicals for their herbicidal efficiency and effects on soybeans. In these preliminary tests several treatments showed promise, including the following: tris-(2,4-dichlorophenoxyethyl) phosphite (2,4-DEP) at 2 pounds per acre; 2-chloro-*N,N*-diallylacetamide (CDAA) at 5 pounds; 2-chloroallyl diethyldithiocarbamate (CDEC) at 5 pounds; sodium 2,4-dichlorophenoxyethyl sulfate (sesone) at 3 pounds; sodium salt of *N*-1-naphthylphthalamic acid (NPA, sodium salt) at 4 to 6 pounds; 2-methyl-4-chlorophenoxy-propionic acid (MCPP) at 1½ to 2 pounds; alkanolamine salts of 4,6-dinitro-*o*-sec-butylphenol (DNBP, alkanolamine salts) at 6 pounds; sodium pentachlorophenate (PCP, sodium salt) at 16 pounds; and 2-chloro-4,6-bis(diethylamino)-*s*-triazine (chlorazine) at 6 pounds.

Burt (4) found that of over 20 chemical treatments applied pre-emergence to soybeans on sandy soils at Gainesville, Florida, 8 pounds per acre of the sodium salt of PCP gave the most satisfactory weed control without crop injury. Isopropyl *N*-(3-chlorophenyl)carbamate (CIPC) also gave excellent control of annual weeds at 9 pounds per acre, but presented the hazard of occasional crop injury. Ethyl *N,N*-di-*n*-propylthiocarbamate (EPTC) at the 5 and 10 pound rates responded similarly. Previously, Burt (2) had tested both CDAA and CDEC. Although he found they were well tolerated by soybean plants, they gave an erratic weed control response on his light soils.

Peters *et. al.* (7) also obtained outstanding results with the sodium salt of PCP on their silt loam soils in Missouri. In their trials, CIPC and DNBP produced severe injury, while CDAA failed to give satisfactory weed control.

On loam and loamy sand soils in Delaware, Indyk (6) obtained good responses with the sodium salt of PCP, CDAA, and CDEC, and with mixtures of PCP with CDEC and with the isopropyl ester of 2,4-dichlorophenoxyacetic acid (2,4-D). He agreed with Burt that PCP should be recommended for commercial use, pending the establishment of residue tolerances and registration.

A research program to develop means of practical weed control in soybeans on Florida's organic soils was initiated at the Zellwood Farm of the Central Florida Experiment Station during 1956. Use of herbicides, alone or coupled with mechanical cultivation, was studied in all experiments. First stage tests consisted of observational trials wherein several selective herbicides, including the newer chemicals as they appeared, were screened to detect their activity on the weeds and soybeans. In the second stage trials, herbicides appearing superior in the screening trials were used in replicated plots to study their influence on crop yields. The third stage trials involved large scale testing in commercial fields. The results and conclusions from these experiments are presented in this bulletin.

EXPERIMENTAL PROCEDURE

Primary Evaluation Trials

During the summers of 1956, 1957, and 1958, soybeans were grown in five primary evaluation or screening trials for the purpose of selecting the more promising herbicides among the several being offered by the chemical industry. These experiments are listed in Table 1 along with planting and treatment dates and the total numbers of chemicals and individual treatments included in each test.

TABLE 1.—PRIMARY EVALUATION TRIALS USED TO SCREEN HERBICIDES APPLIED PRE-EMERGENT TO SOYBEANS ON ORGANIC SOIL.

Experiment No.	Date Planted	Date Treated	No. of Chemicals	No. of Treatments*
56-1	June 19, 1956	June 22	15	30
56-2	July 13, 1956	July 13	15	41
56-3	Sept. 26, 1956	Sept. 27-28	17	34
57-1	May 7, 1957	May 8-9	15	34
58-1	May 22, 1958	May 22-23	23	50

* Number of treatments excludes the untreated check plots which were interspersed repeatedly among the treatment plots of these trials.

For each of these trials, the beans were planted in single unreplicated rows, usually adjacent to other agronomic or vegetable crops. The plots were defined by crossing the crop rows at right angles with the herbicide strips. In all cases, the chemicals were dissolved, emulsified, or suspended in water and sprayed over the soil surface after planting and before emergence of both the soybeans and the weeds. During 1956, the 5-foot wide plots were treated using a three-nozzle hand sprayer. A tractor-mounted herbicide sprayer was used subsequently. The tractor wheels, 6 feet apart, marked the plot boundaries. In all cases, the sprays were applied broadcast, using flat-fan weed control nozzles spaced 10 inches apart. Generally, untreated check plots were located after every second chemical plot. Since this placed each treatment either adjacent to or near a weedy check, accurate comparisons were feasible. This also made it possible to readily ascertain variations in the natural weed populations of the experimental fields.

Eleven different varieties were planted and treated in the first two tests in 1956, but due to poor seed quality, data were

recorded only for the variety CNS-24. This same Clemson line was used for Experiments 56-3 and 57-1. Of the two varieties planted in Experiment 58-1, data are reported only for Lee, a grain type comparable to CNS-24. The other variety, Otootan, was a forage type, but responded similar to Lee.

A total of 25 different chemicals were screened to evaluate weed killing efficiency and to determine which might be sprayed safely over the soil surface pre-emergence to soybeans. Herbicides studied are listed in Table 2 along with information on the formulation of each chemical tested. For convenience in the discussions and tables, common names or experimental designations which are recognized and accepted by the Terminology Committee of the Weed Society of America are used for chemicals throughout this publication (9). There are, however, no accepted common names for two of the herbicides included in these tests. These are 2,5-dichloro-3-nitrobenzoic acid, referred to by the company designation "Dinoben", and the mixture of 2-chloro-*N,N*-diallylacetamide and trichlorobenzyl chloride, here designated as "CDAA-TCBC". In several cases, the designation refers to the active agent although salts of these chemicals were actually used. These include the sodium salts of NPA, PCP, TCA, and 2,3,6-TBA. The 2,4-D formulation contained the amine salt, and the DNBP consisted of a mixture of alkanol-amine salts.

Herbicide treatment rates are specified in terms of pounds per acre of the active chemical ingredients. In most cases, this is the content of technical chemical, but acid or phenol equivalents are used where more appropriate, as in the cases of 2,4-D and DNBP, respectively.

The initial selection of herbicides and rates used in these trials was based on suggestions supplied by commercial sources of the chemicals and on information reported by other research workers. Sometimes it was necessary to increase the chemical rates used on this organic soil to two or more times those commonly suggested for weed control on light mineral soils.

Data from these primary evaluation trials were recorded in the form of visual ratings. Since the tests were observational and unreplicated, quantitative measurements were not made. Ratings were determined by direct comparisons between treated plots and untreated check areas. A 10 increment scale, ranging from 0 to 10, was utilized for both observed factors, as follows:

TABLE 2.—HERBICIDES USED IN SOYBEAN WEED CONTROL INVESTIGATIONS, 1956 TO 1958.

No.	Common Name or Designation	Chemical Name	Formulation*
1	amitrole	3-amino-1,2,4-triazole	50% S.P.
2	atrazine	2-chloro-4-ethylamino-6-isopropylamino-s-triazine	50% W.P.
3	CDAA	2-chloro-N,N-diallylacetamide	4 lb/gal E.C.
4	CDAA-TCBC**	2-chloro-N,N-diallylacetamide + trichlorobenzyl chloride	3 lb CDAA + 5 lb TCBC/gal E.C.
5	CDEC	2-chloroallyl diethyldithiocarbamate	4 lb/gal E.C.
6	chlorazine	2-chloro-4,6-bis(diethylamino)-s-triazine	4 lb/gal E.C.
7	CIPC	isopropyl-N-(3-chlorophenyl)-carbamate	4 lb/gal E.C.
8	Dinoben**	2,5-dichloro-3-nitrobenzoic acid	80% S.P.
9	diuron	3-(3,4-dichlorophenyl)-1,1-dimethyl urea	80% W.P.
10	DNBP	4,6-dinitro-o-sec-butylphenol, alkanolamine salts	3 lb/gal S.C.
11	EPTC	ethyl-N,N-di-n-propylthiocarbamate	6 lb/gal E.C.
12	EXD	ethyl xanthogen disulfide	5 lb/gal E. C.
13	fenumon TCA	3-phenyl-1,1-dimethylurea trichloroacetate	3 lb/gal E.C.
14	ipazine	2-chloro-4-diethylamino-6-isopropylamino-s-triazine	2 lb/gal E.C.
15	monuron	3-(<i>p</i> -chlorophenyl)-1,1-dimethylurea	80% W.P.
16	NPA	N-1-naphthylphthalamic acid, sodium salt	2 lb/gal S.C.
17	PCP	pentachlorophenol, sodium salt	75% S.P.
18	propazine	2-chloro-4,6-bis(isopropylamino)-s-triazine	50% W.P.
19	sesone	sodium 2,4-dichlorophenoxyethyl sulfate	90% S.P.
20	simazine	2-chloro-4-6-bis(ethylamino)-s-triazine	50% W.P.
21	TCA	trichloroacetic acid, sodium salt	90% S.P.
22	triетazine	2-chloro-4-ethylamino-6-diethylamino-s-triazine	50% W.P.
23	2,3,6-TBA	2,3,6-trichlorobenzoic acid, sodium salt	1.5 lb/gal S.C.
24	2,4-D	2,4-dichlorophenoxyacetic acid, amine salt	4 lb/gal S. C.
25	2,4-DEP	tris(2,4-dichlorophenoxyethyl)-phosphite	2 lb/gal E.C.

* Formulations are given as follows: E.C.—emulsifiable concentrate; S.C.—soluble concentrate; S.P.—soluble powder; W.P.—wettable powder.

** Designations not accepted by the Terminology Committee of the Weed Society of America and the American Standards Association.

Weed control: 0 indicates no effect on weeds, no control;
8 indicates commercially acceptable control;
10 indicates complete control or weed kill.

Crop tolerance: 0 indicates no crop tolerance, complete elimination of the crop;
8 indicates good tolerance with slight, usually temporary, crop injury;
10 indicates full tolerance of the chemical with no harmful effect on the crop.

The weeds were classed into two groups, broadleaf weeds and annual grasses. Separate control ratings were recorded for each. The use of this scale for crop tolerance, the reverse of crop injury, was selected to keep both scales positive in relation to desirable characteristics. Thus, large numerical values represent favorable results on both scales. Conversely, low ratings reflect poor weed control and serious injury to the soybean plants. Intermediate levels describe partial control or crop tolerance and may be interpreted as though each increment were roughly equivalent to 10 percent. Thus each rating, multiplied by 10, gives the approximate percentage weed control or crop tolerance, estimated in terms of both stand and growth of the plants.

Secondary Evaluation Trials

Secondary or advanced herbicide evaluation was accomplished by replicated yield trials conducted during the 1957 and 1958 crop seasons.

In Experiment 57-2, the varieties Lee, Jackson, and CNS-4 were planted on July 2, 1957, using 1 bushel of seed per acre in rows spaced 36 inches apart. The plots were arranged in a split-plot, randomized-block design with four replications. Each of the three variety plots within each block was subdivided into 10 treatment plots involving three rates of each of three herbicides and a cultivated check. The individual treatment sub-plots were four rows or 12 feet wide and 22 feet long. Chemical treatments were as follows: CDA at 6, 9, and 12 pounds per acre; EPTC at 5, 10, and 15 pounds per acre; and PCP at 10, 15, and 20 pounds per acre. These were all applied broadcast as surface sprays pre-emergent to the soybeans and weeds on July 3 and 4, 1957, using a tractor-mounted weed-control sprayer designed for

small plot work. The delivery rate, using Teejet number 8001 nozzle tips, 25 pounds per square inch pressure at the boom, and 2.7 miles per hour tractor speed, was approximately 24 gallons per acre.

During the first six weeks, until lay-by time, the check plots were cultivated and hand hoed as needed to keep them free of weeds. Treated plots were left untouched until that time, then the whole experimental area was given a single cultivation. Soil moisture during this period was moderately high. Rainfall, shown in Table 4, averaged 1.46 inches per week for this six-week period. Experiment 58-2 was designed similarly, using only two varieties, Lee and CNS-4. The Jackson variety was omitted, since it appeared to be poorly adapted to these organic soils. The beans were seeded in rows 36 inches apart at the rate of 1 bushel per acre on July 17, 1958. Each of the three replications were split into two variety strips. These in turn were composed of nine randomized treatment sub-plots four rows (12 feet) wide by 21 feet long. Because of its favorable action in the screening trials, CDEC was tested in addition to the three herbicides used during 1957. Making up the nine treatments were two rates of each of the four chemicals plus the check, which again was hoed and cultivated. In this 1958 experiment, CDAA was used at 4 and 6 pounds per acre, CDEC at 4 and 6 pounds per acre, EPTC at 8 and 12 pounds per acre, and PCP at 8 and 12 pounds per acre. The treatments were applied one day after planting pre-emergent to both crop and weeds. The same equipment and procedures were used as in 1957 except that the nozzles were assembled with number 8002 tips delivering 35 gallons of spray per acre.

Weed control and crop tolerance responses to the treatments in these secondary tests were observed and recorded using the same rating scales described for the primary evaluation trials. In addition, single 16-foot plot rows were harvested and threshed during late November of each year. The beans were then taken to Gainesville, where they were cleaned, brought to a uniform moisture content, and weighed to the nearest gram. The yields were calculated in bushels per acre.

RESULTS AND DISCUSSION

Primary Evaluation Trials

Each of the five primary evaluation trials was observed several times during the few weeks following application of the pre-emergence chemical treatments. The number of days from treatment to observation is given in Table 3, along with rainfall and temperature data recorded during each experiment. This information aids considerably in explaining the observed responses to the chemical treatments. Visual ratings from all experiments involving each of the 25 herbicides have been summarized and are given in the Appendix. Data were recorded twice from Experiments 56-1 and 56-3. Since the weed control and soybean tolerance ratings for both dates corresponded closely, only the means are given in the result tables.

TABLE 3.—RAINFALL, TEMPERATURE, AND DAYS FROM TREATMENT TO OBSERVATION OCCURRING WITH FIVE SOYBEAN PRIMARY EVALUATION TRIALS, 1956 TO 1958.

Experiment No.	Soil Moisture on Treatment Date	Rainfall After Treatment		Mean Temperature*	Days from Treatment to Observation
		1st week	1st 3 weeks		
56-1	dry	1.70	3.33	81.0	23**
56-2	moderately dry	0.20	0.65	82.5	39
56-3	moderate	0.16	8.98	76.4	20**
57-1	moderate	1.84	4.29	78.2	19
58-1	moderate	1.59	1.64	78.9	28

* Mean temperatures are averages of mean daily minimums and mean daily maximums for first three weeks after treatments were applied.

** Days from treatment to observation given for Experiments 56-1 and 56-3 are averages for two observation dates, in each case approximately two and four weeks after treatment dates.

Five different annual weeds were common to all of these screening trials, since all were conducted during the warm season on the same organic soil farm of the Central Florida Station. The weed species are detailed later along with the discussion of results of the secondary evaluation trials. For these primary trials, the weeds were classed in two general categories, broadleaf weeds and grasses. Though sedges were present in some of

the plots, the populations were too small and variable to permit rating.

Chemical rates were varied from season to season in an effort to learn which ones were most desirable from the standpoint of both weed control and crop tolerance. Since other crops in addition to soybeans were planted in some of these trials, these rates were not always adjusted in favor of this one crop. Some chemical treatments were judged to be unsatisfactory early and were excluded from the later tests. Treatment eliminations were based on the following factors:

1. Inadequate weed control;
2. Insufficient tolerance of crop to chemical;
3. Too little latitude between the threshold chemical level of good weed control and the highest rate tolerated by the crop without injury;
4. Wide variability in performance in different tests, revealing extreme sensitivity to environmental factors;
5. Poor chemical formulation, mechanically unsuited to commercial use;
6. Required herbicide rates too high for convenient or economical application;
7. Danger to succeeding crops from persistent residues; and
8. Lack of interest by herbicide manufacturers in product development and government registration. In several cases, satisfactory herbicide treatments have been found for certain crops, but where there are not adequate patent controls or where the potential sales volume for the herbicide is small, companies can not justify further development cost.

A brief discussion of each of the herbicides included in these screening trials, with an analysis of the responses observed, is given in the Appendix with the data for each chemical. Commonly known characteristics of chemicals beyond those displayed in these tests are occasionally given, since they are often important in determining the future disposition of a new weed killer. The herbicides are treated using the same common names or designations and alphabetical order as listed in Table 2.

Of the 25 chemicals screened in these trials, 21 were eliminated from further consideration, mainly because of poor weed control or poor crop tolerance. In some cases, adequate weed

control without crop damage was possible at very high rates, but such treatments were neither mechanically or economically practical. Selected for further study were four chemicals. These were CDAA, CDEC, EPTC, and PCP. CDEC was not included in the first yield trial in 1957, because at that time its activity did not appear noticeably different from that of CDAA, which was already registered for use on seed crops of soybeans. It was found desirable to include CDEC in 1958, however, because of its slightly superior broadleaf weed control.

Secondary Evaluation Trials

Experiment 57-2.—Due in part to the rainfall and excellent moisture conditions prevailing (Table 4), weed control was good in all treatment plots in this experiment. In contrast, weeds in the adjacent unsprayed and uncultivated border rows flourished.

TABLE 4.—RAINFALL ON TWO SOYBEAN SECONDARY EVALUATION TRIALS DURING SIX WEEKS BETWEEN PLANTING AND LAY-BY, 1957 AND 1958.

Week After Treatment	Rainfall on Exp. 57-2			Rainfall on Exp. 58-2		
	Daily records		Total for week	Daily records		Total for week
	Date	Inches		Date	Inches	
First	Jul. 4 8	0.42 .23	0.65	Jul. 18 21 22	0.03 .23 .24	0.50
Second	Jul. 16	1.25	1.25	Jul. 25 28	0.35 .38	0.73
Third	Jul. 18 19 22	0.10 .40 .51	1.01	Aug. 4 6 7	0.27 .58 .49	1.34
Fourth	Jul. 29 30 31	0.41 .70 .24	1.35	Aug. 11	0.79	0.79
Fifth	Aug. 1 5 6 7	0.31 2.04 .03 .94	3.32	Aug. 18 19 20	0.56 .54 .03	1.13
Sixth	Aug. 8 12 14	0.45 .18 .57	1.20	Aug. 25	0.79	0.79
Six Weeks' Total:			8.78			5.28
Weekly Average:			1.46			0.88

In these rows, they completely covered and were smothering the soybeans by lay-by time. Check plots required frequent cultivations and hand hoeings to keep them clean. Weed species populations, ascertained from several counts in the border areas, were approximately as follows:

Careless weed (<i>Acnida cuspidata</i>)	7%
Goosegrass (<i>Eleusine indica</i>)	35%
Ground cherry (<i>Physalis angulata</i>)	5%
Purslane (<i>Portulaca oleracea</i>)	5%
Spiny amaranth (<i>Amaranthus spinosus</i>)	30%
Yellow sedge (<i>Cyperus odoratus</i>)	18%

All of these, including the sedge, were growing as annuals from seed.

Weed control and soybean crop tolerance ratings were recorded on July 22, approximately three weeks after planting. In Table 5, all broadleaf weed species were considered as a group and rated separately from the goosegrass. At this time, the yellow sedge was not prominent. Eleven days later, on August 2, the plots were all rated again, with the five leading weed spe-

TABLE 5.—WEED CONTROL AND SOYBEAN TOLERANCE RATINGS FROM HERBICIDE SECONDARY EVALUATION TRIAL, RECORDED JULY 22, THREE WEEKS AFTER PLANTING—EXPERIMENT 57-2.

Treatment	lb/A	Weed Control Ratings*		Crop Tolerance Ratings*
		Broadleaf	Grass	
CDAA	6	8.8	8.6	10.0
	9	9.0	9.2	9.2
	12	9.2	9.2	9.7
EPTC	5	7.9	8.6	10.0
	10	8.5	9.5	10.0
	15	8.9	9.6	10.0
PCP	10	8.9	7.2	10.0
	15	9.5	7.8	9.8
	20	9.7	8.2	10.0
Check - cultivated		9.0	9.0	10.0
L.S.D. (5% level)		1.0	0.8	N.S.

* Weed control and crop tolerance ratings were based on a 0 to 10 scale, with high values indicating favorable results. Data are means of 12 observations taken from three variety blocks and four replications.

cies being considered separately. Individual weed control ratings were made for careless weed, goosegrass, purslane, spiny amaranth, and yellow sedge. These data, along with the ratings for crop tolerance to the nine herbicide treatments and the check, are given in Table 6.

The data show that all chemical treatments resulted in excellent weed control, and few of the responses differed significantly from others. The only treatment resulting in broadleaf weed control inferior to others was EPTC at 5 pounds. This was entirely due to the high tolerance of spiny amaranth to this chemical (Fig. 2). At the first observation date, CDAA gave nearly complete control of all weed species, missing only an occasional broadleaf weed at the lower 6 pound rate (Fig. 3). After 11 more days and 2.17 inches of additional rainfall, the CDAA treatments had weakened slightly, permitting some development of several species, including the yellow sedge. While PCP persisted as a good broadleaf weed killer, it was weaker than the other two chemicals on grass at both observation dates (Fig. 4). In most of these PCP plots, surviving grass appeared in streaks, indicating an uneven distribution of the chemical at the time of application.

TABLE 6.—WEED CONTROL AND SOYBEAN TOLERANCE RATINGS FROM HERBICIDE SECONDARY EVALUATION TRIAL, RECORDED AUGUST 2, 4½ WEEKS AFTER PLANTING—EXPERIMENT 57-2.

		Weed Control Ratings*					
Treatment		Careless weed	Goose-grass	Purs-lane	Spiny amaranth	Yellow sedge	Crop tolerance ratings*
Chemical	lb/A						
CDAA	6	8.9	7.3	8.9	8.1	6.8	10.0
	9	9.0	8.2	8.9	7.8	7.2	9.6
	12	9.1	7.4	8.7	7.8	7.0	9.8
EPTC	5	9.3	7.8	8.8	7.5	8.2	10.0
	10	9.4	9.0	9.2	8.3	9.4	10.0
	15	9.4	9.2	8.6	8.6	9.6	10.0
PCP	10	8.6	6.9	8.7	9.1	8.1	10.0
	15	9.8	7.3	9.2	9.3	8.2	10.0
	20	9.8	7.7	9.2	9.4	8.8	10.0
Check - cultivated		9.0	9.0	9.0	9.0	9.0	10.0
L.S.D. (5% level)		1.1	1.0	N.S.	0.8	1.2	N.S.

* Weed control and crop tolerance ratings were based on a 0 to 10 scale, with high values indicating favorable results. Data are means of 12 observations taken from three variety blocks and four replications.



Fig. 2.—Weed control in plot which received 10 pounds per acre of EPTC three weeks after pre-emergence spraying. Note occasional resistant spiny amaranth plants. Unsprayed check rows are at right.



Fig. 3.—Weed control in plot which received 6 pounds per acre of CDAA three weeks after pre-emergence spraying. One purslane and two or three spiny amaranth plants appear in the plot. Unsprayed check rows are at right.



Fig. 4.—Weed control in plot which received 15 pounds per acre of PCP three weeks after pre-emergence spraying. Note scattered resistant goosegrass plants. Unsprayed check rows are at right.

There was little noticeable variation in either size or vigor of the soybean plants growing in any of the plots. Recorded tolerance ratings revealed no significant differences at either date. Due to a lack of consistency, the slight injury in certain high rate CDA plots was questionable. The weed pattern indicated that this was probably due to uneven spray distribution by partially clogged nozzles.

Mean yields of cleaned and dried soybeans from these plots are summarized in Table 7. Variance analysis reveals that there was no difference in the production of soybeans between any of the treatments or between treatments and cultivated checks.

Average ratings from the July 22 observation date and yield data are further consolidated in Table 8. None of the effects appearing in this table show statistically significant differences, except the yield response of the three varieties. Jackson yielded considerably less than either Lee or CNS-4, a response not influenced by the herbicide treatments, since the *treatment x variety* interaction was not significant. A comparison of the mean of all check plots with the total of all chemical treatments shows a yield difference of 2.4 bushels in favor of the check. This trend is supported by mean yields for treatment rates. Although approaching significance, these differences were in-

TABLE 7.—YIELDS OF THREE VARIETIES OF SOYBEANS FOLLOWING HERBICIDE TREATMENT—EXPERIMENT 57-2.

Treatment		Bushels per Acre*			
Chemical	lb/A	CNS-4	Jackson	Lee	Average
CDAA	6	32.7	24.1	34.4	30.4
	9	28.1	21.6	37.8	29.2
	12	34.0	23.8	30.0	29.3
EPTC	5	35.0	23.1	31.6	29.9
	10	32.0	26.4	33.0	30.4
	15	33.9	24.4	33.0	30.4
PCP	10	33.7	23.3	35.7	30.8
	15	29.4	22.4	34.3	28.7
	20	30.7	21.7	32.7	28.4
Check - cultivated		34.6	23.6	38.1	32.1

* Data are means from four replications. There were no significant differences, except between varieties.

TABLE 8.—SUMMARY OF WEED CONTROL AND SOYBEAN TOLERANCE RATINGS AND YIELDS FOLLOWING HERBICIDE TREATMENT IN SECONDARY EVALUATION TRIAL—EXPERIMENT 57-2.

Factors		Weed Control Ratings*	Crop Tolerance Ratings*	Yield (bushels/A)
Chemicals:	CDAA	9.0	9.6	29.6
	EPTC	8.8	10.0	30.2
	PCP	8.5	10.0	29.3
L.S.D. (5% level)		N.S.**	N.S.	N.S.
Treatment rates:	None (Check)	9.0	10.0	32.1
	Low	8.5	10.0	30.4
	Medium	9.0	9.7	29.4
	High	9.3	9.9	29.3
L.S.D. (5% level)		N.S.	N.S.	N.S.
Check vs. chemicals:	Check	9.0	10.0	32.1
	All chemicals	8.9	9.9	29.7
L.S.D. (5% level)		N.S.	N.S.	N.S.
Varieties:	Lee	8.9	10.0	34.1
	Jackson	8.7	9.9	23.4
	CNS-4	8.8	9.7	32.4
L.S.D. (5% level)		N.S.	N.S.	2.7

* Weed control and crop tolerance ratings were based on a 0 to 10 scale, with high values indicating favorable results.

** Differences not significant.

sufficient to prove a reduction in yield as a result of the use of herbicides.

Experiment 58-2.—Although weed control was slightly less perfect in this 1958 trial, it was again commercially adequate with all chemicals and rates tested. The natural weed population, as counted in the check plots before cultivation, was limited primarily to three annual species, as follows:

Goosegrass (<i>Eleusine indica</i>)	80%
Purslane (<i>Portulaca oleracea</i>)	9%
Spiny amaranth (<i>Amaranthus spinosus</i>)	10%
Miscellaneous species	1%

A summary of the weed control and crop tolerance observations is given in Table 9. PCP was inferior to the other three chemicals in this trial, especially with regard to control of goosegrass. CDEC, not included in the 1957 experiment, performed very well, giving slightly better broadleaf weed control than CDAA (Fig. 5). Response to EPTC, notably erratic following surface spray applications, was again very satisfactory in this test. This was possibly due to the fact that the soil was fairly dry at the time of application, permitting rapid absorption of the EPTC by the soil particles. Subsequent rainfall during the next few days assisted the downward chemical movement into

TABLE 9.—WEED CONTROL AND SOYBEAN TOLERANCE RATINGS FROM HERBICIDE SECONDARY EVALUATION TRIAL—EXPERIMENT 58-2.

Chemical	Treatment	Weed Control Ratings*		Crop Tolerance Ratings*
		Broadleaf	Grass	
CDAA	4	8.2	9.2	10.0
	6	8.4	9.3	10.0
CDEC	4	9.5	9.0	10.0
	6	9.8	9.1	10.0
EPTC	8	9.1	9.4	10.0
	12	9.5	9.8	10.0
PCP	8	7.0	6.4	10.0
	12	8.0	7.2	10.0
Check - cultivated		8.5	8.5	10.0
L.S.D. (5% level)		1.1	0.9	N.S.

* Weed control and crop tolerance ratings were based on a 0 to 10 scale, with high values indicating favorable results. Data are means of 12 observations from two varieties, three replications, and two record dates, August 4 and 12.

the surface soil, thus preventing its loss by vaporization. None of the chemical treatments produced visible crop injury.

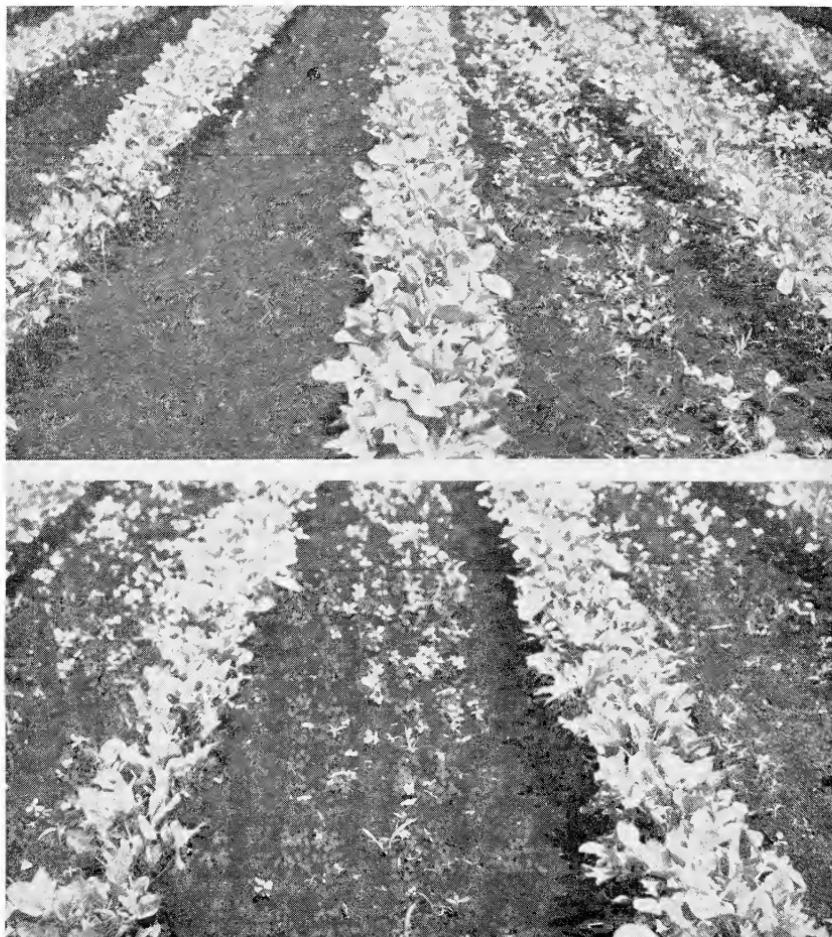


Fig. 5.—Weed control three weeks after pre-emergence spraying with 6 pounds per acre of CDEC. Upper: Broadcast—note complete absence of weeds in contrast with check area at right. Lower: Banded—12 inch bands were applied over two center rows. Adjacent rows were left untreated.

Yields of soybeans were taken as in 1957. Mean yield data for all nine treatment plots and the two varieties are given in Table 10. Again, there were no differences in yields between any of the chemical treatments or between the treatments and the checks, which were hoed and cultivated. To make comparisons easier, these data have been condensed to isolate individual factors in Table 11. Here it may be seen that the weakness of

TABLE 10.—YIELDS OF TWO VARIETIES OF SOYBEANS FOLLOWING PRE-EMERGENCE HERBICIDE TREATMENT IN SECONDARY EVALUATION TRIAL—EXPERIMENT 58-2.

Treatment		Bushels per Acre*		
Chemical	lb/A	CNS-4	Lee	Average
CDAA	4	33.8	36.2	35.0
	6	30.6	40.5	35.6
CDEC	4	30.4	38.3	34.4
	6	34.8	37.9	36.4
EPTC	8	30.9	38.7	34.8
	12	34.4	37.8	36.1
PCP	8	32.1	32.8	32.5
	12	35.4	31.1	33.2
Check - cultivated		34.1	33.4	33.8

* Data are means of three replications. There were no significant differences, except between varieties.

TABLE 11.—SUMMARY OF WEED CONTROL AND SOYBEAN TOLERANCE RATINGS AND YIELDS FOLLOWING HERBICIDE TREATMENT IN SECONDARY EVALUATION TRIAL—EXPERIMENT 58-2.

Factors		Weed Control Ratings*	Crop Tolerance Ratings*	Yield (bushels/A)
Chemicals:	CDAA	8.8	10.0	35.3
	CDEC	9.4	10.0	35.4
	EPTC	9.5	10.0	35.4
	PCP	7.2	10.0	32.8
L.S.D. (5% level)		1.1	N.S.**	N.S.
Treatment rates:	None (Check)	8.5	10.0	33.8
	Low	8.5	10.0	34.2
	High	8.9	10.0	35.3
L.S.D. (5% level)		N.S.	N.S.	N.S.
Check vs. chemicals:	Check	8.5	10.0	33.8
	All chemicals	8.7	10.0	34.7
L.S.D. (5% level)		N.S.	N.S.	N.S.
Varieties:	CNS-4	8.6	10.0	32.9
	Lee	8.1	10.0	36.3
L.S.D. (5% level)		N.S.	N.S.	3.0

* Weed control and crop tolerance ratings were based on a 0 to 10 scale, with high values indicating favorable results.

** Differences not significant.

PCP was the only significant effect revealed by the weed control ratings. Mean crop tolerance ratings of 10.0 for all factors show the lack of any visible crop toxicity. In the case of yields, the only measurable difference was between varieties. In contrast to the 1957 results, in this experiment Lee slightly outyielded CNS-4. In line with the poorer weed control observed early during the growing season, the PCP treated plots yielded slightly fewer soybeans than did either the check plots or those treated by any of the other chemicals. These differences, however, were not statistically significant.

SUMMARY AND CONCLUSIONS

During the years 1956, 1957, and 1958, five screening trials were conducted on the organic soil at Zellwood to evaluate 25 different selective herbicides, applied pre-emergence for weed control in soybeans. Out of these trials, four chemicals were selected for more detailed studies in advanced replicated trials. These were CDAA, CDEC, EPTC, and PCP. All of these gave excellent weed control without crop injury at rates considered satisfactory for the development of a practical treatment.

The discarded chemicals were eliminated for reasons such as poor weed control, crop injury, too great variability in activity, or combinations of these factors. The chemical rates required to give adequate weed control on this organic soil often were found to be higher than would be economically convenient to use or practical. In others, the useful zone between the threshold chemical level just giving satisfactory weed control and the highest rate tolerated by the crop was too narrow to give any factor of safety to the grower.

The advanced herbicide evaluation program included two replicated yield trials. The first was conducted during 1957 using three rates of each of three herbicides and three varieties. CDAA was applied at 6, 9, and 12 pounds per acre; EPTC at 5, 10, and 15 pounds per acre; and PCP at 10, 15, and 20 pounds per acre. All treatments performed very well, giving excellent weed control without producing any significant injury to the crop. This was further corroborated by the yield data, which proved that none of the treatments injured the soybeans sufficiently to cause a reduction in the bushels of beans produced.

A similar trial in the summer of 1958 tested CDEC in addition to the chemicals used during 1957. Since the high rates

used in 1957 proved to be unnecessary, two low rates of each chemical were selected for this second trial. CDAA and CDEC at 4 and 6 pounds per acre and EPTC at 8 and 12 pounds all gave excellent weed control, in some cases surpassing that secured by hoeing and cultivating. With both 8 and 12 pounds of PCP, however, observed weed control, especially of grasses, was poorer than that obtained in the other treatment plots or the cultivated checks. The soybean plants tolerated all herbicide treatments used in this experiment without showing visible symptoms of chemical injury. Again, as in the first trial, yields in 1958 did not reflect any effects attributable to herbicide treatments.

Further studies with PCP are not warranted at the present time, although it performed well in several tests. Since it is not superior to CDAA and CDEC, which are already registered and available to growers, there is little justification for additional development costs for toxicity tests and needed formulation improvement. Also, there is little commercial interest in this herbicide, due to a lack of adequate patent controls.

EPTC applied as a surface spray gave excellent weed control without harming soybeans. Considering present costs for the rates required on organic soil, this chemical does not compete favorably with CDEC or CDAA. Also, difficulty has appeared at other locations where the use of EPTC has resulted in weed control failures or crop injury. Soil moisture at the time of application appears to be an influencing factor. Further studies involving lower rates of EPTC incorporated into the surface soil are planned. At present, EPTC is not registered with the U. S. Department of Agriculture for use on soybeans.

This leaves two herbicides of proven value selected among the 25 evaluated for pre-emergence control of annual weeds in soybeans on central Florida organic soils. These chemicals, CDAA and CDEC, have given excellent weed control at rates from 4 to 6 pounds per acre and were used safely on soybeans at 8 or more pounds. At the lower rates, CDAA was found to be slightly more effective against grasses than CDEC. The latter, on the other hand, gave slightly superior control of broadleaf weeds than did CDAA. Both have been approved by the Food and Drug Administration and are registered by the U. S. Department of Agriculture for grower use on soybeans. Each is available in both emulsifiable concentrate and granular formulations, under the proprietary names "Randox" and "Vegadex" for CDAA and CDEC, respectively. Confirming the experimen-

tal results, these herbicides were used with two successful grower plantings involving over 400 acres of soybeans during the 1958 and 1959 crop seasons. Both CDAA and CDEC at 4 and 6 pounds per acre were found to be commercially practical in these large-scale trials.

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APPENDIX

Following are data and notes dealing with the primary evaluation trials. Weed control and crop tolerance ratings were based on a 0 to 10 scale, with high values indicating favorable results.

Amitrole.—Amitrole was a good broadleaf weed killer, but was less effective against grasses. Although the 6 pound per acre rate was insufficient for good grass control, it was slightly toxic to soybeans, causing chlorosis and dwarfing of the plants. This ruled out higher rates necessary for better annual grass control.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
3	56-3	6.7	6.7	10.0
	58-1	10.0	3.3	10.0
6	56-3	8.9	7.8	8.9
	58-1	10.0	6.7	10.0

Atrazine.—In the single trial where it was observed, atrazine performed like other triazine compounds, producing toxicity symptoms on soybeans. It was an excellent weed killer, but the 4-pound rate yellowed and stunted the crop. Although 2 pounds performed well here, 3 pounds have usually been necessary to give dependable weed control on this soil. This leaves too narrow a margin for safety below the level toxic to the crop.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
2	58-1	10.0	8.9	10.0
	58-1	10.0	9.4	7.8

CDAA.—With the exception of one experiment, number 56-2, use of this chemical at 3 or more pounds per acre resulted in excellent weed control. Crop tolerance was good at all rates up to 8 pounds per acre. CDAA was selected for further testing in advanced trials.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
2	57-1	7.8	7.8	10.0
3	56-2	1.1	5.6	10.0
	56-3	9.4	9.4	10.0
	58-1	10.0	9.4	10.0
4	56-2	1.1	7.8	10.0
	57-1	8.9	8.9	10.0
6	56-1	9.2	9.6	8.3
	56-2	3.3	8.9	8.9
	56-3	10.0	10.0	9.4
	57-1	10.0	8.9	10.0
	58-1	10.0	10.0	10.0
8	56-2	5.6	5.6	10.0
12	56-1	9.6	9.6	7.0

CDAA + TCBC.—This mixture of CDAA and trichlorobenzyl chloride was developed to give an improved kill of broadleaf weeds in corn over that given by CDAA alone. In the single 1958 test reported here, its performance was comparable to that of CDAA. However, its known toxicity to broadleaved plants, including soybeans, as reported by other workers, makes it inferior to CDAA for use with this crop.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
2 $\frac{1}{4}$ + 3 $\frac{3}{4}$	58-1	10.0	9.4	10.0
4 $\frac{1}{2}$ + 7 $\frac{1}{2}$	58-1	10.0	10.0	10.0

CDEC.—This chemical, sold under the trade name "Vegadex", gave consistently favorable results when used at rates of 4 to 8 pounds per acre. It is much more effective on organic soil than on Florida light sands, where it frequently fails to give good weed control. In these tests, serious crop injury was observed only in Experiment 56-1, where 12 pounds per acre were applied. Only one-third of that amount was usually necessary to give adequate weed control on this Zellwood soil. Because of this wide safety margin above the herbicidally effective rates, CDEC was selected for further evaluation in the secondary trials.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
2	57-1	6.7	6.7	10.0
3	56-2	7.8	6.7	10.0
	56-3	9.4	9.4	10.0
	58-1	10.0	8.9	10.0
4	56-2	10.0	8.9	10.0
	57-1	7.8	7.8	10.0
6	56-1	9.6	9.6	8.3
	56-2	10.0	10.0	10.0
	56-3	10.0	10.0	10.0
	57-1	8.9	8.9	10.0
	58-1	10.0	9.4	10.0
8	56-2	10.0	10.0	10.0
12	56-1	10.0	10.0	5.9

Chlorazine.—This triazine—the first to reach the commercial developmental stage—has been tested extensively for use on soybeans by several workers. Although the crop appeared relatively tolerant in these organic soil screening trials, weed control, even at 16 pounds per acre, proved to be insufficient to justify continued appraisal of chlorazine after 1956.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
6	56-3	9.4	5.0	10.0
8	56-1	9.2	6.7	9.7
	56-2	7.8	7.8	10.0
12	56-2	7.8	7.8	10.0
	56-3	10.0	7.2	9.4
16	56-1	9.6	8.9	9.7
	56-2	7.8	7.8	10.0

CIPC.—The performance of CIPC when applied during warm weather was very erratic. Under hot dry conditions, such as those prevailing during Experiment 56-2, this volatile chemical was almost completely lost. On organic soil, soybeans displayed tolerance to extremely high rates, ranging to 20 pounds per acre, but kill of broadleaf weeds and annual grasses was not dependable.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
5	56-3	6.7	6.1	10.0
	57-1	4.4	4.4	10.0
7 1/2	58-1	6.7	7.8	8.9
8	56-1	9.2	3.6	10.0
10	56-3	8.3	8.9	10.0
	57-1	6.7	6.7	10.0
15	58-1	8.9	8.9	7.8
16	56-1	10.0	6.7	10.0
	56-2	0	0	10.0
20	56-2	2.2	0	10.0

Dinoben.—This experimental herbicide, 2,5-dichloro-3-nitrobenzoic acid, at 4 pounds per acre performed well when first tested on soybeans in 1958. Phytotoxicity was severe at 8 pounds. Although further work with this chemical was planned, its production was discontinued by the manufacturer, making it unavailable for testing after 1958. According to recent reports from others, a reduced form of Dinoben, 3-amino-2,5-dichlorobenzoic acid, with the coined name amiben, has consistently surpassed Dinoben in performance. Amiben will be included in future trials as part of this herbicide program for soybeans.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
4	58-1	8.9	9.4	8.9
8	58-1	9.4	10.0	4.4

Diuron.—Diuron failed to give dependable weed control on peat soil at 1 and 2 pounds per acre. Even though soybeans appeared to be tolerant to higher rates, including 4 pounds, the possibility of crop injury and the danger to succeeding crops make such treatments impractical. Diuron is an efficient broadleaf herbicide and is generally non-selective with regard to such plants. Its low water solubility and consequent persistence in soils has led to its widespread use as a durable soil sterilant where total eradication of plants is desired.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
1	56-3	8.9	5.6	10.0
	57-1	7.8	5.6	10.0
	58-1	6.7	3.3	10.0
2	56-1	9.6	4.7	10.0
	56-2	8.9	8.9	10.0
	56-3	10.0	8.9	9.4
	57-1	8.9	6.7	10.0
	58-1	7.8	6.7	10.0
4	56-1	9.6	8.5	9.7
	56-2	10.0	10.0	10.0

DNBP.—The high tolerance of soybeans to the alkanolamine salts of DNBP has led to widespread testing with this herbicide. At Zellwood, however, weed control was not sufficiently dependable to merit inclusion of this chemical in the replicated trials.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
3	56-2	0	0	10.0
	56-3	6.1	6.7	10.0
	57-1	2.2	2.2	10.0
4 1/2	56-2	0	0	10.0
	58-1	7.8	8.9	10.0
6	56-1	9.6	8.5	10.0
	56-2	2.2	0	10.0
	56-3	8.3	8.3	10.0
	57-1	6.7	5.6	8.9
9	57-1	7.8	6.7	7.8
	58-1	9.4	9.4	10.0
12	56-1	10.0	10.0	10.0
	56-2	4.4	0	10.0

EPTC.—Applied as a pre-emergence spray and left on the soil surface, EPTC produced little or no phytotoxic effect on soybeans at rates up to 18 pounds per acre of active ingredient. Although its control of broadleaf weeds in these primary evaluation trials was only fair, EPTC was selected for inclusion in the advanced trials because of its excellent grass control and because of favorable results reported by Burt (3). Further screening tests with this chemical were planned using lower rates incorporated into the soil to reduce volatilization losses. Several workers, including Antognini, *et al.* (1), have reported that the activity of EPTC is enhanced when it is used in this manner.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
4	58-1	6.7	10.0	10.0
5	57-1	7.8	8.9	10.0
6	56-1	2.9	9.6	9.4
	56-3	6.7	8.9	10.0
8	58-1	7.8	10.0	10.0
10	57-1	7.8	8.9	10.0
12	56-1	4.0	10.0	8.9
	56-2	4.4	10.0	10.0
	56-3	8.3	10.0	10.0
	58-1	8.9	10.0	10.0
15	57-1	8.9	10.0	10.0
18	56-2	8.9	10.0	10.0

EXD.—This chemical failed to give weed control when tested on organic soil at 15 and 30 pounds per acre.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
15	57-1	0	1.1	10.0
30	57-1	0	3.3	10.0

Fenuron TCA.—Soybeans were severely damaged by this chemical preparation even at 1½ pounds per acre, which was insufficient for good weed control. At 2 to 4 pound rates, fenuron TCA gave complete control of all broadleaf weed species, but was weaker on grasses.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
1 ½	58-1	7.8	5.6	5.6
2	57-1	10.0	6.7	8.9
3	58-1	10.0	7.8	2.2
4	57-1	10.0	7.8	7.8

Ipazine.—In the 1958 trial, ipazine gave complete broadleaf weed control but resulted in very poor grass control and severe crop damage. Its failure to produce any effect on either the weeds or soybeans in the 1957 trial was attributed to a poor chemical formulation wherein the active ingredient had precipitated prior to use.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
1	57-1	0	0	10.0
2	57-1	0	0	10.0
	58-1	10.0	1.1	3.3
4	58-1	10.0	4.4	0

Monuron.—Two pounds of monuron, like diuron, gave good broadleaf weed control but only fair grass control. In the 1957 trial, the weed control was the same for both of these substituted urea compounds, but monuron was more toxic to soybeans. This precluded its use at higher rates.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
1	57-1	6.7	5.6	10.0
	58-1	7.8	5.6	10.0
2	57-1	8.9	6.7	7.8
	58-1	8.9	7.8	10.0

NPA.—Although it was not toxic to soybeans, trials with NPA on organic soil were discontinued after 1956 because it was ineffective in controlling weeds, especially grasses. Under the hot dry soil conditions of Experiment 56-2, even 20 pounds per acre gave no grass control. High rates such as this are economically impractical, since 10 gallons of commercial formulation would be required to supply this much technical chemical.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
8	56-1	8.1	3.6	10.0
	56-3	8.3	5.6	10.0
16	56-1	7.8	5.9	10.0
	56-2	5.6	0	10.0
	56-3	8.9	7.2	10.0
20	56-2	6.7	0	10.0

PCP.—Weed control with this sodium salt of pentachlorophenol at rates ranging from 6 to 15 pounds per acre was good in all trials except in Experiment 56-2. Failure in this test was attributed to moisture deficiency in addition to faulty application resulting from clogged spray nozzle screens and tips. The industrial formulation of PCP used contained a considerable quantity of gums or other insoluble ingredients. Since this chemical did not produce crop injury in any of the tests, it was selected for inclusion in the advanced trials.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
6	56-2	0	0	10.0
	56-3	7.2	7.2	10.0
7½	56-1	9.6	7.8	10.0
	58-1	8.9	7.8	10.0
9	56-2	1.1	0	10.0
12	56-2	3.3	0	10.0
	56-3	9.4	8.3	10.0
15	56-1	10.0	9.2	10.0
	56-2	5.6	0	10.0
	58-1	10.0	9.4	10.0

Propazine.—Although a good pre-emergent weed killer, propazine at 4 pounds per acre resulted in severe crop injury when used in 1958. Soybeans tolerated 2 pounds, but some annual grass survived, indicating no margin of safety.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
2	58-1	10.0	7.8	10.0
4	58-1	10.0	8.9	1.1

Sesone.—According to these tests, 5 to 10 pounds of sesone were required to give adequate control of both broadleaf weeds and grasses on organic soil. These rates were toxic to soybeans all 3 years.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
3	56-3	5.6	7.8	9.4
4	58-1	5.6	7.8	10.0
5	57-1	8.9	8.9	7.8
6	56-3	7.2	8.9	8.9
8	58-1	8.9	8.9	5.6
10	57-1	10.0	8.9	5.6

Simazine.—Most extensively tested of the five triazine compounds included in these trials, simazine appeared to be an excellent weed killer at all rates from 1 to 6 pounds per acre. At levels of 2 or more pounds per acre, it frequently was toxic to soybeans. This eliminated it from further consideration as a selective herbicide for use with this crop.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
1	57-1	10.0	7.8	10.0
1 1/2	56-3	10.0	8.9	10.0
2	56-2	8.9	8.9	10.0
	57-1	10.0	8.9	10.0
	58-1	8.9	7.8	6.7
3	56-1	9.6	9.6	8.1
	56-2	8.9	8.9	10.0
	56-3	10.0	10.0	8.9
4	56-2	10.0	8.9	10.0
	58-1	10.0	8.9	3.3
6	56-1	10.0	10.0	4.7

TCA.—The effectiveness of sodium trichloroacetate, the form of TCA used here, on both crop and weeds was extremely variable. It is a water soluble herbicide, and at times high rates apparently dissipated completely without any effect on the weeds. At other times, low rates produced severe crop injury.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
9	56-1	2.9	4.4	10.0
	56-3	4.4	7.8	6.7
10	57-1	6.7	7.8	5.6
	58-1	6.7	8.9	3.3
18	56-1	4.7	8.5	10.0
	56-2	0	0	10.0
	56-3	7.2	9.4	5.0
20	57-1	7.8	7.8	4.4
	58-1	7.8	10.0	1.1
22½	56-2	0	0	10.0

Trietazine.—Use of this chemical at 4 pounds per acre resulted in excellent broadleaf weed control, but only fair grass control and some crop injury, sufficient to eliminate it from future consideration for soybeans.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
2	58-1	8.9	5.6	10.0
4	58-1	10.0	7.8	7.8

2,3,6-TBA.—This trichlorobenzoate, a sodium salt consisting of a mixture of six isomers with the 2,3,6- isomer predominating, was found to be exceedingly toxic to soybeans. It has not been included in the tests since 1956. Its persistent residual activity in peat soil would be a further deterrent to its use with any crop in this area. Residues in plots where it had been used in 1956 produced severe injury to succeeding crops in 1957.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
3	56-1	8.5	6.7	5.2
	56-3	9.4	6.7	4.9
6	56-1	8.5	8.1	3.3
	56-2	7.8	10.0	2.2
	56-3	10.0	8.3	2.2
9	56-2	8.9	10.0	1.1

2,4-D.—In the 1956 tests, soybeans appeared to be completely tolerant to pre-emergence applications of the amine salt of 2,4-D up to 4 pounds per acre. During 1957 and 1958, however, even 1 pound produced severe stand reductions and plant stunting. Weed control was not dependable at rates below 3 pounds.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
1	56-1	5.9	4.7	10.0
	56-3	4.9	6.1	10.0
	57-1	8.9	7.8	6.7
	58-1	7.8	8.9	6.7
2	56-1	8.9	6.7	10.0
	56-2	6.7	7.8	10.0
	56-3	6.7	7.8	10.0
	57-1	10.0	8.9	4.4
	58-1	8.9	9.4	3.3
3	56-2	7.8	10.0	10.0
4	56-2	8.9	10.0	10.0

2,4-DEP.—Even though soybeans displayed considerable tolerance to 2,4-DEP, excessively high quantities were required to give adequate broadleaf weed control. It proved to be a good grass killer on organic soil, frequently effective 6 or 7 weeks after application.

Rate (lb/A)	Experiment No.	Weed Control Ratings		Crop Tolerance Rating
		Broadleaf	Grass	
6	56-1	5.1	8.5	10.0
	56-3	5.6	7.8	8.9
	57-1	6.7	7.8	10.0
	58-1	9.4	8.9	10.0
12	56-1	6.3	9.6	9.1
	56-2	7.8	10.0	8.9
	56-3	6.7	8.9	7.8
	57-1	8.9	8.9	7.8
	58-1	10.0	10.0	10.0
18	56-2	8.9	10.0	8.9



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